

may be due to lead poisoning. According to a study by Herbert Needleman of the University of Pittsburgh School of Medicine and colleagues published in February in the *Journal of the American Medical Association*, boys with higher bone-lead levels are more likely to be aggressive and delinquent.

"This is probably the most critical study that has been done on lead in the last five years," says Janet Phoenix, manager of public health programs at the National Lead Information Center of the National Safety Council, an international public interest organization. "The social implications are enormous."

Lead has been linked with behavioral problems since the early 1940s, when pediatrician R.K. Byers noted that some children he had treated for acute lead poisoning subsequently developed violent, aggressive behavioral difficulties such as attacking teachers with knives or scissors. Needleman's study, supported in part by the NIEHS, is the first to link asymptomatic levels of lead with aggressive behavior and delinquency.

Needleman and his colleagues studied 301 boys from primary schools in Pittsburgh. The researchers measured bone-lead levels by K X-ray fluorescence when the boys were about 12 years old. Based on the relative lead content of their tibias, the boys were divided into high- and low-lead groups. Bone-lead levels reflect lifetime exposure to lead because, like calcium, lead is stored in bones. The boys in the high-lead group had normal levels of lead in their blood by the time of the study, showing that their lead exposure had occurred in the past.

The researchers evaluated the boys' behavior at 7 and 11 years of age based on reports from three sources: the boys themselves, their parents, and their teachers. These data were from widely respected tests of antisocial behavior that had been administered by the Pittsburgh Youth Study, a longitudinal study of the developmental course of delinquency. At 11 years, the boys were given a self-reported delinquency interview, which comprises 35 questions such as how many times in the past six months a subject has "been drunk in a public place" or "attacked someone with a weapon." The parents and teachers filled out the child behavior checklist, which contains 113 symptoms of childhood behavioral disorders such as cruelty or bullying, shoplifting, setting fires, and apparent lack of guilt after misbehaving.

When the high-lead boys were 7 years

Closing Chernobyl

Almost 10 years after the explosion and full-scale meltdown of a graphite core at the Chernobyl nuclear power plant in Ukraine, officials finally agreed to close the plant.

The governments of Ukraine, the Group of Seven (G-7) industrialized nations, and the Commission of the European Communities signed a memorandum of understanding on 20 December 1995 that outlines a comprehensive program for the closure of the Chernobyl nuclear power plant by the year 2000. The program's provisions include a focus on nuclear safety; the development of a financially sound electric power market with market-based pricing to encourage energy efficiency and conservation; and a social impact plan to address the effects of the closure of the plant on its employees and their families. Representatives of Ukraine, the G-7, and international financial institutions plan to meet annually to monitor the implementation of the program.

The memorandum allocates \$2.3 billion in aid, including \$349 million for nuclear safety and decommissioning activities and \$1.9 billion for new energy investments. The funding will come from grants by G-7 countries and loans from international financial institutions, although the financing has not yet been worked out.

Financial details and the fact that the agreement is not legally binding have caused environmental groups to remain skeptical about the agreement. "If the West does not provide what Ukraine feels is sufficient capital, it's quite possible that Chernobyl might not be shut

down," said Miriam Bowling, a research associate for the Natural Resource Defense Council's nuclear program. In addition, Bowling said, Ukraine faces political pressure from the Russian government, which prefers that Chernobyl stays open.

Environmental groups are also disappointed that the agreement includes the exchange of the closure of Chernobyl for the completion of two more nuclear reactors in Ukraine. However, as Bowling said, "It is a very important agreement, and it's great to see the words 'Chernobyl' and 'closure' on the same piece of paper."



old, neither they nor their parents reported significant behavioral problems, and their teachers reported only borderline tendencies toward symptoms such as social problems, delinquency, and aggressive behavior. By the time these boys were 11, however, they reported significant increases in antisocial acts, and their parents and teachers reported significant increases in symptoms such as delinquent and aggressive behavior. The researchers corrected for confounding factors such as the mothers' intelligence, the presence of the father, and socioeconomic status.

Many U.S. children have toxic bone-lead levels and—provided that their results are found to extend to the population at large—Needleman and his colleagues conclude that lead makes a substantial contribution to delinquent behavior. Other researchers hail the Needleman study as the first to rigorously demonstrate a link between lead and antisocial behavior. The study was well-designed and its implications are likely to be valid,

according to Terrie Moffitt of the Department of Psychology at the University of Wisconsin at Madison. Self-reporting is trustworthy when the period reported on is less than a year, the interviews are private and face-to-face, and confidentiality is guaranteed, she says, and the Needleman study met these conditions. Furthermore, Needleman's conclusions are strengthened by the fact that reports from three sources—the boys, their parents, and their teachers—all linked lead with antisocial behavior.

Lead is a neurotoxin and human studies indicate that its neurological effects are likely to be irreversible. However, delinquency is also associated with factors such as weak parent-child attachment, lax parental supervision, and school failure. Addressing these issues can mitigate the effects of lead. "These kids need help. They need support from teachers and parents," says Phoenix. "No one knew they were lead-poisoned." The good news is that environmental lead exposure can be avoided. "Lead-related delinquency is the easiest to prevent," says Needleman. "We should be able to wipe this disease out by removing old lead-based paint."